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SHORT NOTE

INDUCTION OF LARVAL METAMORPHOSIS OF *ARCHASTER TYPICUS* (ECHINODERMATA: ASTEROIDEA)[1]

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Chang-Po Chen and Jin-Quan Run (1991) Induction of larval metamorphosis of *Archaster typicus* (Echinodermata: Asteroidea). *Bull. Inst. Zool., Academia Sinica* **30**(3): 255-258. Brachiolaria larvae of the sea star were induced to settle and metamorphose by insoluble inducer(s) on the walls of beakers which had been used to culture the larvae for at least one week.

Key words: Settlement, Starfish.

It is important for the planktonic larvae of benthic invertebrates to find a suitable place for setting and metamorphosing. Environmental cues and the ability of larvae to receive the cues are fundamental. Inducing factors may come from many different ways. Some are related to prey species (Chia and Rice, 1978; Chen *et al.*, 1990), habitat (Pawlik and Faulkner, 1986; Marsden *et al.*, 1990) or adult species (Burke, 1986).

Larvae of asteroids are induced to settle and metamorphose by a wide variety of substrata, and lacking suitable substrata may delay their metamorphoses (see Strathmann, 1978 for review). However, the roles of substrata, whether they provide a physical adhesive surface or contain chemical inducing factors, have not been well addressed.

During the reproductive season, the male of the sea star *Archaster typicus* mounts the female and is induced to release sperm by the spawning female (Run *et al.*, 1988), thus enhancing fertilization success. After hatching, the larvae become pelagic. It takes about 10 days for planktotrophic larvae to develop through brachiolaria to juveniles in the laboratory (Yamaguchi, 1977; Komatsu, 1983; personal observation). Brachiolaria larvae of this species have been induced to settle and metamorphose on the blades of the seagrass *Halophila ovalis*, which were covered with epiphytic microalgae and fine sediments (Yamaguchi, 1977). Our preliminary studies revealed that the brachiolaria larvae of *A. typicus* metamorphosed in culture beakers without any other substrata. Therefore, we examined the roles of substrata in inducing the settlement and metamorphosis of *A. typicus*. Two questions were asked: whether

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or not inclucing factor(s) were present in our culture system, and where were the inducer factor(s) located.

MATERIALS AND METHODS

Adult *Archaster typicus* Muller and Troschel were collected from the intertidal sandy flats of the Penghu Islands (23°32′N; 119°33′E), Taiwan, in May 1988. They were induced to spawn by injecting 1-methyladenine (30 μg of 1-methyladenine dissolved in 2.5 ml filtered sea water) into the coelomic cavities (0.5 ml per arm) of the mounted females (Kanatani, 1969; Run *et al.*, 1988) About 20 minutes after injection, the females spawned and then the males followed by releasing sperm, with fertilization then occurring.

Embryos were reared in weakly agitated seawater (35‰ S). After hatching, the larvae were transferred to 400 ml beakers containing filtered seawater with the planktonic alga *Isochrysis galbana* at a concentration of 2 to 5×10^4 cells/ml. The larvae were reared at 26°C without agitation under constant light (ca. 500 lux fluorescent light). All beakers were cleaned by scrubbing vigorously with cheese-cloth, soaked in tap water overnight, then rinsed with deionized water and dried in an oven at 60°C.

Each of following two experiments had two replicates, i.e., beakers. All competent brachiolaria larvae came from the same stock and 30 were reared in each beaker. The cumulative number of metamorphosed individuals was monitored in each beaker.

Exp. 1, Effect of fouling on metamorphosis

In this experiment, we asked whether or not inducing factor(s) were present in the fouled culture system. In the experimental group, competent brachiolaria larvae were cultured in the conditioned beaker with conditioned seawater. The term "conditioned" denotes the culture seawater and beaker in which larvae have been reared for more than one week with some larvae having just metamorphosed in this fouled culture beaker. Competent brachiolaria larvae cultured in a clean breaker containing 0.45 μm filtered seawater served as the control group.

Exp. 2, Inducing ability of different components of the fouled culture system

In this experiment, we asked where the inducing factor(s) were located. The fouled culture system was separated into three parts: the conditioned beaker, the conditioned seawater passed through a 0.45 μm membrane filter, and the particles retained on the filter membrane. The inducing abilities of these three parts were tested as follows: competent brachiolaria larvae were reared in (1) the conditioned beaker containing 0.45 μm filtered seawater, (2) a clean beaker containing the filtered membrane retained particles and the 0.45 μm filtered seawater, and (3) a cleaned beaker containing the conditioned seawater passed through a 0.45 μm filter membrane.

RESULTS

Exp. 1, Effect of fouling on metamorphosis

Almost all brachiolaria larvae (95%) settled and metamorphosed on the second day in the fouled culture systems and none occurred in the clean, unfouled beakers (Table 1). This indicated that inducer(s) were present in the fouled culture system.

Exp. 2, Inducing ability of different components of the fouled culture system

On the third day, 73% of brachiolaria larvae settled and metamorphosed in the conditioned beaker and 35% of them in the clearn beaker containing particles larger than 0.45 μm on the filter membrane.

Table 1
Cumulative number of brachiolaria larvae of *Archaster typicus* being induced to settle and metamorphose in the fouled culture system

Duplicate / Day	Fouled Culture System		0.45 μm Filtered Seawater in Clean Beaker	
	1	2	1	2
1	10	2	0	0
2	30	27	0	0
Percentage (%)	100	91	0	0

Table 2
Cumulative number of brachiolaria of *Archaster typicus* being induced to settle and metamorphose by different components of the fouled culture system: conditioned beaker, solution passed 0.45 μm filter and particles on the filter membrane

Duplicate / Day	Cond. Beaker		Passed Solution		Retained Particles	
	1	2	1	2	1	2
1	11	2	0	0	3	5
2	26	18	0	0	10	6
3	26	18	0	0	12	9
Percentage (%)	87	60	0	0	40	30

None brachiolaria larvae had settled on the clean beaker which contained the conditioned seawater passed through the 0.45 μm filter membrane (Table 2). These results indicate that inducer(s) are present on the wall of the beaker and the particles larger than 0.45 μm but not in the filtered conditioned seawater.

DISCUSSION

The results of this study clearly revealed that the brachiolaria larvae of *Archaster typicus* are induced to settle and metamorphose by inducer(s) fouled in the culture system, especially on the wall of the culture beakers. Therefore, we infer that the role of substrata in inducing larval metamorphosis of *A. typicus* is likely to provide a biofouled surface, coated with insoluble inducer(s) which are produced by microorganisms.

Microorganisms also play an important function in the larval settlement and metamorphosis of the seastar, *Luidia sarsi* (Wilson, 1978) and many sea urchins *Arachnoides placenta* (Chen and Run, 1989), *Mellita quinquesperforata* (Caldwell, 1972), *Arbacia punctulata* and *Lytechinus pictus* (Cameron and Hinegarder, 1974). Microorganisms which produce the inducing factor, may be related to the food items of the newly settled juveniles of *Archaster typicus* and other echinoderms mentioned above.

The mechanism of microorganisms in inducing metamorphosis has not yet been understood. To date, we do not know what microorganisms are involved, what inducer(s) are produced and how larvae receive them. One of the mechanisms

may involve the release of neurotransmitters such as L-dopa by microorganisms (Weiner *et al.*, 1985). These substances are absorbed by larvae which then trigger the event of metamorphosis (Chen and Huang, 1990).

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海星 *Archaster typicus* 幼生之誘引變態

陳章波　阮靜觀

此種海星的小腕幼生被某不溶解的物質誘引而附著變態。該誘引物質主要附著在飼育過幼生的燒坏壁上。